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CONTENTS

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ADDRESS AT THE DEDICATION OF THE WALKER LABORATORY OF THE RENSSELAER POLYTECHNIC INSTITUTE

I CONSIDER it an honored privilege to be allowed to take part in the ceremony of dedication of this beautiful building devoted to the study and promotion of the science of chemistry in its application to the arts and industries. In this connection it behooves us I think to consider briefly the history of the movement which brings us together, to ponder the purposes of the great institute, of which the work to be done in this building constitutes an integral and important part.

Thinking over what I might be able to present on this occasion it occurred to me to make some inspection of the historic archives of the city of Troy, particularly as they relate to the founding of this, which has taken such a proud position among the educational institutions of the world. In my search I learned that in 1823 Hon. Stephen Van Rensselaer made, most wisely in his lifetime, provision for a school to be located on the outskirts of the city of Troy to be known as the Rensselaer School, and the history of this fact written by Weise offers a copy of the first circular issued to announce that the institution was ready for practical operation, as follows:

Hon. Stephen Van Rensselaer having established a school near the northern limits of Troy for teaching the physical sciences with their applications to the arts of life, having appointed Professors A. S. Eaton and L. C. Beck to give courses of instruction, particularly calculated to prepare

operative chemists and practical naturalists properly qualified to act as teachers in villages and school districts; having appointed an agent and furnished him with funds for procuring apparatus and fitting up laboratories and a library room, etc., and the agent having given notice to the president of the institution that the requisite collections and preparations are completed, it seems proper to give public notice of the circumstances. Accordingly, the public is respectfully notified that everything is in readiness at the Rensselaer School for giving instruction in chemistry, experimental philosophy and natural history, with their applications to agriculture, domestic economy and the arts, and also for teaching land surveying and all the branches of learning set forth in the circular which was issued in November last, subscribed by the founder and by the president and secretary of the board of trustees. The first term will commence, according to the appointment of the founder, on the first Monday in January, 1825, and continue fifteen weeks.

An evening course by the senior professor in chemistry and experimental philosophy will commence on the third Wednesday in January and continue, three lectures a week, for ten weeks.

(Signed) SAMUEL BLATCHFORD

Rensselaer School, December 28, 1824.

And so the school was launched, to provide for the study of chemistry, experimental philosophy and natural history with their applications to agriculture, domestic economy and the arts and for teaching land surveying and other branches of learning set forth in this circular. What prophetic vision Van Rensselaer possessed! He saw among other things the importance of liberal education to the life work of every man, and so provided for, in addition to the professional or technical branches of study, training in other branches of learning, presumably the culture studies, essential to the training of every educated man. But note further, that special provision was made first, for the study of chemistry; then for the study of experimental philosophy, or what we now know as physics; and after that natural history, or what we now class generally as biology. These three, chemistry, physics and biology; what better, could have, then or now, been imagined for the broad training of one who should make a life work of the essential arts of life? Van Rensselaer had trouble also to sharply differentiate between chemistry and physics and to give one precedence over the other. For as chemistry applied in the arts is chemical technology, so physics applied in the arts, in a large way, is engineering; and as the dividing line between chemistry and physics is obscure, so, as Van Rensselaer, even in his day, recognized, chemistry and engineering must go hand in hand if progress in the arts is to be assured.

No better illustration of this is to be found than appears around us here. We stand to-day upon historic ground. Here the great engineer Ericsson found his first financial encouragement and support at the hands of those captains of industry and finance, Griswold and Winslow. Encouraged and guided by these master minds, Ericsson was able to complete the historic *Monitor* and make the white squadron possible. Here was the cradle of the Bessemer process, which made the steel industry of the United States possible and enabled our country to develop the great United States Steel Corporation and lead the world in the manufacture of steel.

There are those, doubtless, who will question what I have just said regarding the priority of Troy in the effective establishment of the Bessemer process for manufacture of steel, but such high authority as R. W. Hunt, one of the pioneers in the industry in this country, says ("Life of Sir Henry Bessemer," *Sibley Journal of Engineering,* 1904, 161): "Hence the honor of the first heat of Bessemer steel in America belongs to the Wyandotte Works." But he also said (History of the Bessemer Steel Manufac-

ture in America, American Institute of Mining Engineers, Vol. V., 1876–1877): "While at the Wyandotte Works steel was made at an earlier date, the Troy establishment was the first to bring the process to a commercial success."

A great chemist once said that the measure of a nation's civilization is its consumption of soap. While this has in the passing years lost none of its truth, the more modern expression becomes—the measure of a nation's civilization is its consumption of fuel and its production and utilization of steel. This is a measure of the supremacy of the United States and we may be proud to-day that we stand in the cradle of the industry which makes this declaration effective. For history tells us that Holley, returning from a trip abroad, where he had made a study of the new and recent discovery of Sir Henry Bessemer and Mushet, associated with him the two enterprising and farsighted gentlemen already mentioned, Griswold and Winslow, in the establishment of the new process on American soil at Troy. As Bessemer had worked out the physical and engineering part of the work, Mushet had seen and worked out the chemical part of the process, and thus made perfection possible. Chemistry and engineering working together, moving forward hand in hand, had brought forth this realization of the greatest step in the world's progress.

What a splendid illustration of the suggestion of the great Tyndall, "the scientific use of the imagination." The imagination of Bessemer saw the possibilities of the new process and the means whereby it could be carried out mechanically; the imagination of Mushet saw the chemical difficulties in the way of ultimate successful operation and how they should be removed. Holley, after the installation of the process on the soil of the United States, saw in imagination the changes necessary to the more perfect realization of the dreams of Bessemer and gave to the industry an impetus which carried it with a terrific rush throughout the length and breadth of our land. For the knowledge and experience of Bessemer were limited to mechanics and engineering. He had noticed that a blast of air across a bath of molten iron changed the physical properties of the product to those of wrought iron and steel. He saw in the old puddling process the importance of access of air to the molten metal to effect the necessary change in its physical properties to change it to wrought iron and steel. His imagination showed him the possibility of improved mechanical means for effecting these necessary changes by a blast of air through the hot metal, but his imagination was limited by his knowledge and it was not possible for him to determine when his treatment should be stopped. The knowledge of chemistry of Mushet told him that oxidation of the carbon was the cause of the change in physical properties already noted and his imagination led him to the thought that the practical end of Bessemer's process, to get exact results, would be to burn away all the carbon of the iron and add afterward to the bath a definite quantity of carbon, dependent upon the quality of steel desired. So he devised the addition of spiegeleisen at the end of the blow, when the flame of carbon had disappeared from the mouth of the converter, the addition of a substance rich in carbon to supply this essential element, accompanied by manganese capable of reducing the iron oxidized in the converter after oxidation of the carbon of the original iron, and so to relieve the steel of the "shortness" so fatal to its future use. The Bessemer steel process must have, therefore, chemical control as well as engineering direction.

The necessity Van Rensselaer saw has been realized, and his munificence has made just such combinations possible. The imaginations of Holley and Roebling and Collingwood and Boller and Hodge have made possible the wonderful bridges spanning the great rivers of the world, the network of railroads stretched across the continent, which insures transportation and commerce, but the products which afford realization of these imaginations must have the care and control of the chemist from the earth, from which the raw material sprung, to the wires and bars which constitute the great structures which excite wonder and admiration.

But the founder of the institute saw more in the arts of life. He saw necessity for provision for the immediate wants of mankind, the food and raiment, the removal and utilization of wastes, and if the former may seem to have been neglected by the institute, the latter surely have not. Here is another measure of the civilization of a nation, the utilization of its wastes. Nowhere in the world, perhaps, has this had more intelligent and effective study than in the department of chemistry of the institute. The purity and abundance of the domestic water supply and the healthful and economic disposal of human wastes have in all ages of the world been of the highest public importance. The function of the municipal engineer has been called into activity, and the world is beginning to reap the fruits of its practical application. It is not always true that "fools rush in where angels fear to tread," but rather that wisdom of knowledge courageously leads in untried paths where ignorance blindly follows. The known leads to the unknown. The present builds upon the experience of the past. It is thus that knowledge brings progress, and study, however obscure, brings help and comfort to mankind.

The value of the special knowledge of natural forces and their laws, which Van Rensselaer foresaw, is coming to be more and more appreciated in the commercial world. During the present year the most important representative of the financial interests, *The Wall Street Journal,* said, editorially, under the caption "Science as a Financial Asset," inspired doubtless by the address lately delivered by Dr. A. D. Little, of Boston, before the American Chemical Society in annual meeting:

Science as a source of strength in promoting private wealth and public welfare is the one thing that draws the line of demarkation between ancient and modern times. That was a belated medieval, not a modern, outburst of popular wrath against which Lavoisier's friends appealed for his life on the ground of his scientific service to the French state. The powers then in control replied that "the republic had no use for chemists." Far more like modernity is the declaration of a German chemist that "scientific research is the greatest financial asset of the fatherland." Germany's economic progress proves that he was at least much nearer right. The sciences in general have been among the greatest emancipating forces, because they have helped to overcome man's fear of nature, which kept him from utilizing the forces of the world about him, and because they disclosed elements of the highest value to the world in their most practical forms: It has been well said "that if we were to take away what the chemists have contributed, the whole structure of modern society would break down at once. Every commercial transaction in the civilized world is based on the chemist's certificate as to the fineness of gold, which forms our ultimate measure of values. Faith may remove mountains, but modern society relies on dynamite. Without explosives our great engineering works must cease and the Panama Canal, no less than modern warfare, become impossible."

The late Abraham S. Hewitt estimated that the Bessemer process of manufacturing steel added directly and indirectly two thousand million dollars a year to the world's wealth. Bessemer himself retained only about ten million dollars out of

this total annual increment. Without chemistry no such dreams could have been realized. Chemistry has made possible the transportation systems which span the leading countries of the world. It has made it possible to turn to man's service the wealth of the mineral world. By analysis of plants and soils, the waste materials of the world have been brought to the growing of crops. Indeed, every great industry, whether it be farming, manufacturing, transportation or mining, would almost immediately relapse to barbarism if the secrets of the chemist and physicist, the geologist and mineralogist could be gathered up and cast into the sea.

The work of science which probably needs most development in the present day, however, is not so much the application of knowledge already acquired to the increase of wealth as the promotion of research in fields whereby the enormous wastes may be checked and the utilized resources of the world immediately around us be won for man's uses. Fundamental research is by far our greatest need. Common clay is full of a commodity which, if it could only be extracted economically, would probably solve for centuries the question of a metal supply for a large part of the needs of mankind.

It was this thought that led an American journal to say that the accidental killing of Professor Curie, the discoverer of radium, in the streets of Paris last April, was a greater loss to the world than the earthquake in San Francisco, where more than a thousand people lost their lives, a quarter of a million persons were rendered homeless by conflagration and property losses estimated at $500,000,000 occurred. If that be true, it is neither numbers nor wealth, but scientific talent that gives the power of mastery to nations because of its capacity to unlock the secrets of nature, in which are hid the sources of material welfare.

These are words which must bring much of both comfort and encouragement to those who are just entering upon their life work, as well as to those who have had to work and answer the hard questions offered by the industries. Knowledge is a good financial asset, but it must be exact and accurate knowledge. The hard questions submitted to the educated technologist must be answered promptly but accurately. And many, if not most, of the questions now pressing for answer are as much chemical as mechanical. For instance, who shall answer the question as to the cause of, and remedy for, the broken rail? Shall it be the engineer or the chemist? Shall the answer be found in the intense speed and the overload of trains, or in the excess of carbon necessary to provide resistance to wear rail surface, or made necessary by an overweening desire to increase tonnage at expense of quality? or shall it be found in the nitrogen introduced in the steel and now found like phosphorus, to have a profound influence upon the physical property of the product? The world, and particularly the United States, is looking anxiously for the correct answer to this question. Will Troy and her men rise to the situation and now, as in the decade '65 to '75, bring forth a new Bessemer process to supply the new demand? There are those here present, no doubt, who will take inspiration from this question and do their share to supply this instant demand and do it thoroughly. It is for this that the Rensselaer School was founded, and the Walker laboratory generously provided. And failure and disappointment are surely words which do not belong in the local vocabulary.

The value of the study of chemistry in the training of educated technical men has been realized since the time of Van Rensselaer as well as before. In his address on "The Functions of Technical Education" the late Professor Thurston said: "When the pupil is to go directly into business and his precise line of work is not settled, or when it is evident that he is of that large class in this country liable to pass from one vocation to another, the technical studies for the curriculum should be in general, mathematics and the science of physics and particularly of chemistry."

This dictum from the great head of the Sibley School of Engineering is impressive and worthy of careful consideration. It fully justifies our presence here to-day for the purpose in hand and confirms the judgment of the founder of this institute and the purpose of the generous donors of the Walker Laboratory we here and now dedicate to the study of chemistry.

We may heartily join in congratulations to the administrators of the will of Mr. Van Rensselaer, who have so faithfully carried out the purpose of the founder, and to the graduates, who have so well seconded the efforts of these able and conscientious men who have brought the Rensselaer Polytechnic Institute to that great eminence in the public esteem, from which they may look backward with pride and forward in earnest and confident hope of an even brighter and more prosperous future.

WM. MCMURTRIE.

THE RATIONAL BASIS OF MATHEMATICAL PEDAGOGY [1]

THE rapid development of special methods of teaching special subjects has drawn attention of late to the hitherto neglected field of mathematical pedagogy. The fact that mathematics is the last to respond to improved pedagogical methods is due chiefly to the unusual weight of precedent which attaches to the subject. This inertia of age is, in reality, the chief difficulty to be overcome, for the great antiquity of elementary mathematics and the diversity of the sources from which it originated make it extremely difficult to harmonize the subject with the spirit of modern civilization.

Various plans have recently been proposed for adapting mathematical instruction to modern conditions, but so far they have been without results of special importance, as no general principle of mathematical pedagogy seems as yet to be recognized. Many of these plans are the results of attempts to meet local conditions and therefore have no general application. Others, however, such as the attempt to correlate mathematics and physics, are intended to stimulate interest in mathematics by establishing more points of contact between it and the other subjects of instruction, thus producing a greater organic unity in the curriculum than has hitherto existed. Such efforts are in line with the constructive and synthetic spirit which characterizes modern scientific thought, and for this reason are worthy of special consideration.

Without going into a detailed analysis of pedagogical methods, it may be well to consider briefly the fundamental principles on which general pedagogy is based, as these principles are well established and apply with peculiar force to mathematics.

The primary consideration in all branches of pedagogy is the aim of education. This has been variously defined, the Herbartian definition of it being that it is "the cultivation of virtue based on many sidedness of interest." By the cultivation of virtue in this connection must be understood the proper exercise and control of all the faculties. With this understanding the definition fits in, probably as well as any other, with modern ethical and religious ideals. The second half of the definition which bases the development of virtue on the cultivation of wide and varied interests fulfills practical requirements and at the same time affords the proper pedagogical basis for apperception. The most important feature of this definition is that it recognizes both the practical and the cultural aims of education. In other words, it implies that no training can properly be

[1] Read before American Mathematical Society, New York, December 28, 1906.

called educative in which esoteric development does not result in exoteric manifestation. This is especially important in the case of mathematical instruction which exhibits an unfortunate tendency to run to the extremes of either pure logic or empiricism.

Having defined the aim of education, the most efficient means of attaining it becomes the great problem of pedagogy. The first step towards the solution of this problem may be said to have been taken by biology in the establishment of the law of physical evolution. Following out the analogy thus suggested, modern psychology has practically solved the problem by studying the content of the child mind at different ages, thus determining the natural course of mental evolution. In this way it has been conclusively shown that mental processes follow the historical order of development, or, as Herbert Spencer expressed it, that "the genesis of knowledge in the individual follows the same course as the genesis of knowledge in the race." More recently modern psychologists have found even in the most minute activities of the child psychic atavisms as remarkable as convincing, proving conclusively that the natural course of mental evolution is but a repetition of civilization in miniature.

Since pedagogy, like engineering, is chiefly concerned with the utilization of natural forces and their direction in the proper channels, it follows that the fundamental principle underlying general pedagogy must necessarily be the historical method of presentation. In the case of mathematics this is the logical as well as the psychological sequence of development, which obviates many of the difficulties encountered in applying the historical method to other branches of instruction. The historical method thus fulfills the prime requisites for a practical working theory in being simple in application as well as powerful in results.

A notable instance of the application of the historical method to general pedagogy has already been made, and is embodied in the well-known "culture epoch" theory, originated by Pestalozzi and Herbart and elaborated by their disciples.[2] This theory consists, in brief, in applying the evolutionary idea with the utmost detail to the elementary school curriculum, with the purpose of leading the child successively through each stage of culture occupied by the race in the evolution of modern civilization. As a typical instance of the application of this method, Ziller's interpretation of the culture-epoch theory may be cited, as it is now well established in Germany on a practical footing.

In outline Ziller's method consists in arbitrarily selecting eight great historical culture epochs, corresponding as nearly as possible to the first eight years of school life. Material is then selected to embody the culture of each epoch, that chosen by Ziller being as follows: (1) epic fairy tales; (2) Robinson Crusoe; (3) history of the patriarchs; (4) history of the judges in Israel; (5) history of the kings in Israel; (6) life of Christ; (7) acts of the Apostles; (8) history of the Reformation. The subjects thus selected are known as "concentration centers" for the reason that each is used as a nucleus around which to group supplementary courses in language, science, etc. These supplementary courses are then so chosen that each group shall form a unit, representing, so far as possible, a complete stage of civilization in miniature.

The results of Ziller's method are in the main satisfactory, and at least afford a sug-

[2] See any of the numerous treatises on Herbart's educational theories, *e. g.*, "Ufer's Pedagogy of Herbart," by De Garmo; or "Introduction to Herbart's Science and Practise of Education," by Felkin.

gestive instance of the application of the historical method. It is evident, however, that Ziller's interpretation of the dual theory of the culture epochs and concentration centers is open to criticism. This is apparent in the arbitrary selection of the culture epochs, as they only partly typify the great epochs of history. Furthermore, the concentration material selected by Ziller by no means embodies the total experience of the race in any particular epoch, and for this reason is inconsistent with the principle by which it was selected. In applying the theory this weakness has also made itself felt by reason of the impossibility of reproducing historical environment, and the difficulty of adequately presenting the notable characters of ancient civilization without it. These objections have led to severe criticism of the whole culture-epoch theory, and in some cases to its entire rejection.

It should be noted, however, that the difficulties attending the culture-epoch theory are inherent in this theory and not in the historical method. In the case of mathematics the question of environment does not arise, and thus the chief difficulty is at once removed. Moreover, the nature of the subject matter in elementary mathematics is such that none of it can be omitted, thus obviating all possibility of error in the selection of proper materials.

Perhaps the most convincing proof of the applicability of the historical method to mathematics is furnished by the practical methods attained by teachers as the result of long experience. Special aptitude for teaching consists largely in the ability to assume the mental attitude of the pupil, and establish the connection between the ideas already formed and those which it is desired to communicate; or, more briefly, in the ability to stimulate apperception. By long and earnest efforts of this kind such noted teachers as De Morgan, Grube and others have arrived at methods of presentation which in the main follow the historical sequence of development, thus affording a strong inductive proof of the validity of this method. The recognition of the historical method as the universal principle underlying experience by means of which these results may be codified and extended, is, then, all that is necessary to furnish a rational basis for mathematical pedagogy.

In applying the historical method to mathematics, one of the most interesting results is the light which is thrown on the nature of the difficulties encountered in studying the subject. From the fact that mathematics has formed the basis of all civilization, and has developed independently among nations widely separated, it may be assumed that it possesses a certain universality akin to that of mind itself. This is by no means true, however, of the special branches of the subject. Thus it is by no means merely fortuitous that the Greeks excelled in geometry but produced no great algebraists, and that the reverse was the case with the Semitic races. The mathematical attainments of any nation are, in fact, an integral part of its national culture, and may, therefore, be expected to differ in direction with the latter. In so far, then, as mathematics satisfy the common needs of humanity they may justly lay claim to universality, but beyond this point are characterized by the spirit and aims of the nation which gave them birth.

It is not surprising, therefore, that those reared under modern conditions should experience difficulty in assimilating results attained hundreds or thousands of years ago and expressive of a culture entirely foreign to our own; or that they should at times fail to recognize the value of certain branches of the subject. For instance, geometry is still taught in prac-

tically the same form in which it was left by Euclid 2,200 years ago. The great Greek mathematicians, Pythagoras, Plato and Aristotle were, however, primarily philosophers, and the geometry they originated is instinct with Greek idealism. In fact the era of Greek culture may be characterized as the adolescent stage in the intellectual development of humanity. With the Greeks the worship of the ideal and the beautiful rose to the height of a religious cult, and the chief boast of the founders of geometry was that they had raised it above the common needs of humanity, and elevated it to the dignity of pure logic. This view of geometry as typical of the adolescence of the race explains why it appeals to youth and at the same time is criticized as unpractical by those of greater maturity. Euclidean geometry, however, should not be viewed from a practical standpoint only, for since the full power of maturity is only attained by the proper unfolding of the preceding stages of childhood and youth, geometry is an important factor in development, and should not give place to more utilitarian subjects until it has fully served its purpose as a mental stimulus.

As geometry is a characteristic expression of Greek culture, so algebra sprung from, and fitly symbolizes, the mystic spirit of the Hindoos and their Aryan conquerors. For the modern youth, therefore, the difficulties met with in geometry are by no means so great as those encountered in algebra, for the Greek spirit in its two chief features of freedom and individuality has much in common with our own, whereas that of the Hindoos is its exact antithesis. Fettered by the bonds of caste, the Hindoo spirit could not attain objective realization and became lost in a maze of abstraction; the highest good becoming a mere negation of existence both physical and intellectual. Moreover, the divinity ascribed to the Brahmin caste resulted in the degradation of religion, and the absorption of the spiritual in the merely physical. Thus the morality involved in respect for life and its Creator was lost, and the ideal of virtue was abstraction from all activity. In short, concrete reality gave way to abstraction, imagination became dominant, and spirit was characterized by the fanciful imaginings of dreams. The difficulties met with in algebra are therefore inherent in the thought processes involved and can only be lessened by establishing relations with more familiar ideas by the frequent introduction of concrete numerical illustrations.

Besides explaining the nature of the difficulties encountered, the historical method also furnishes a means of estimating their relative magnitude. In other words, the historical method affords a criterion for making a quantitative as well as a qualitative estimate of the intellectual content of the subjects considered. Thus the long period of time occupied by the Egyptians in reducing fractions to a working basis is significant as being the prototype of the serious difficulty experienced by the modern youth in attaining an equal proficiency in the subject. The pause which frequently intervenes between two successive stages of development is also significant, and is analogous to that which occurs at intervals in the growth of the child. As in the case of physical growth, so here, the pause marks a drop in potential due to accelerated development, and its length indicates the importance of the next successive advance. It is in fact a sort of hysteresis due to the mental inertia of the race. Political and religious conditions are not sufficient to account for such halts in progress. Although social conditions must be recognized as powerful factors in aiding or arresting development, yet from the standpoint of universal history such external relations

can not be considered as conditioning the evolution of spirit, but rather as reflecting its trend.

To illustrate the meaning of a pause such as mentioned, the hiatus of sixteen centuries which intervened between the statics of Archimedes and the dynamics of Stevinus and Galileo may be cited. The difficulty experienced by students in passing from statics to kinetics has frequently been remarked by teachers, and has led to a revision of instruction in mechanics by beginning the subject with kinematics and treating statics as a special case of dynamics. This order of development might, however, have been inferred from the historic relation of the subjects, for the history of mechanics shows that the statics of Archimedes consisted in little more than the law of the lever, and that no advance was made until the subject was approached from the standpoint of motion. In fact such an elementary principle of statics as the parallelogram of forces was not proved or even commonly accepted until after the enunciation of Newton's laws of motion. In this case, then, the pause emphasizes the degree of attainment essential to a proper understanding of the laws of motion, and also the necessity of approaching the subject from the proper direction, both of which are of the greatest pedagogical importance.

The long interval of time, approximating 4,000 years, which was spent by the ancients in acquiring the fundamental ideas of number is another instance in point, and indicates the necessity of thoroughness in the first stages of instruction. Here again theory has been anticipated by experience in the method proposed by Grube, which consists in spending the entire two first years of mathematical instruction in exhaustive number analysis. There is no doubt but that under the present forcing system too little time is devoted to this basic work, the result being that ability to make numerical calculations with ease and facility is the exception rather than the rule. This also explains the reason for the unfavorable comparison sometimes drawn between our modern schools with their multiplicity of subjects and too often superficial treatment, and the old red schoolhouse of the last generation, where instruction was limited to the three R's, but where each was taught with such thoroughness as to leave a permanent impress on the character of the scholar.

The movement recently inaugurated in Germany and England with a view to revising the present instruction in mathematics indicates the lack of harmony between ancient and modern civilization. A characteristic expression of this dissatisfaction with existing methods of instruction is found in the so-called "Perry movement" and its rapid spread throughout England and America. The chief feature of the modification proposed by Professor Perry is the laboratory method of instruction, which may be characterized as an attempt to visualize mathematics, at the same time making it utilitarian as well as concrete. It is, therefore, a reversion to the basic needs of humanity and the means which were used for supplying them. Thus arithmetic originated with the Phœnicians and Chaldeans to supply their commercial needs, while even with the Greeks the beginnings of geometry may be traced to the attempt to solve certain practical problems in mensuration. It is, in fact, a general truth that the chief stimulus to the development of mathematics has always been found in the attempt to explain natural phenomena, and make them subservient to the physical needs of humanity. The laboratory method, then, may be used as a basis for the inductive development of mathe-

matics, and if used for this purpose in the lower grades of instruction will prove a valuable adjunct to the methods ordinarily followed. So far from being unique in its inception and aims, however, it is merely a corollary of the historical method, and can only be used to advantage when it is recognized as such.

Another corollary of the historical method is what is known as the "spiral method" of instruction. This consists in taking the pupil several times over the same ground, but each time reaching a higher level and attaining a more general point of view. The method is founded mainly on experience, but its theoretical basis is evidently historical.

The specific application of the historical method to mathematical pedagogy consists primarily in obtaining the proper historical perspective. From this aspect its principal use is in arranging the details of a curriculum, and a few suggestions follow relative to its application for this purpose.

Perhaps the most obvious suggestion is that subjects which developed simultaneously should form parallel courses instead of being taught serially, as is now common in all mathematical instruction. For instance, algebra and geometry originated simultaneously and served as a mutual stimulus to growth and development. It is evident, therefore, that it is possible to teach these subjects in the same academic grade, and that they can undoubtedly be made mutually helpful by so doing. This opinion is verified by the fact that this method has been used for some time in the higher schools of Prussia with results which indicate a decided advantage for such correlation of subjects.[3]

Following out the historical idea, the curriculum should be based on a thorough grounding in the principles of number, the amount of time devoted to the several subjects being proportionate to their relative difficulty as indicated by their historical rate of development. This should be followed by a course in elementary algebra, taught as a generalization of arithmetical ideas, and accompanied by a parallel course in elementary geometry. The course in elementary algebra would naturally consist in a logical development of the six fundamental processes, including logarithms. At present the latter usually follows quadratic equations and the binomial theorem, whereas historically it precedes both. The natural sequence is, in fact, to teach multiplication as an abbreviation of addition, thus leading to the theory of exponents, and then passing to logarithms as an abbreviation of multiplication. Historically the subject of logarithms arose in this connection, having been invented by Napier about 1614 for the purpose of facilitating the long numerical calculations fashionable in his day.

Conforming to the natural lines of demarkation, these elementary courses would be succeeded by advanced courses in algebra and solid geometry, the former beginning with simple equations and emphasizing chiefly the theory of equations. At present the natural sequence is not followed in teaching algebra, at least three subjects, namely, proportion, logarithms and series being out of proper historical perspective. Proportion, or the old-fashioned "rule of three," was developed by the Hindoos for the solution of numerical equations by the "rule of false assumption," and as it is now obsolete for this purpose, does not properly belong in algebra, and should be reserved for arithmetic and geometry, where it properly has a place. The proper setting for logarithms has already been mentioned. As

[3] J. W. A. Young, "The Teaching of Mathematics in the Higher Schools of Prussia."

regards series, great difficulty is usually experienced in grasping the idea of convergency and divergency at the point where it ordinarily occurs in current text-books, the reason being that it involves the idea of functionality which is of comparatively recent development. Euler first noticed in 1748 that convergency of series was necessary for computation and partly developed the idea of functionality, but the subject did not receive adequate consideration until demanded by the development of the calculus.

Two other points may be noted in connection with the teaching of algebra. The first is that the graphical method of representing an equation was originated by Descartes, who was also one of the foremost in developing the theory of equations. The inference is that graphs may be advantageously used to illustrate the theory of equations, and will also serve as a natural transition to analytic geometry. In this way the historical method meets the objection sometimes raised to our present method of instruction as being conducted in "water-tight compartments."

The second point is that the examples used to illustrate principles should be so chosen as to stimulate interest, and in order to accomplish this purpose must reflect modern life and local conditions. That this principle of selection was formerly recognized, or at least followed, is shown by some of the time-honored problems which unfortunately still survive. Thus the length of time required to fill or empty a vessel by several pipes had a practical bearing when time was measured by a clepsydra, while such problems as that of the couriers, and the length of time required by several men to complete a piece of work, were exceeding useful and interesting a century ago, but, now, have no vital interest except perhaps for the historian. The retention of such problems in modern elementary texts is evidence that the spirit of scholasticism is not yet extinct, and largely accounts for the growing chasm between mathematics and the humanities. Modern life in its growing complexity is teeming with possibilities of mathematical illustration, constantly presenting new problems far greater in cultural value and more wide-reaching in practical significance than any that have yet appeared. To revitalize instruction in elementary mathematics the pupil must be taught to recognize the true significance of mathematics, as the most powerful instrument yet devised by man for ameliorating his physical condition and reconciling cause with effect. Philosophy can never be the proper food for childhood and youth; in elementary instruction the essential feature is that it shall be instinct with life and experience.

It is beyond the scope of this article to do more than point out the chief features of the historical method and its application to mathematics. In mathematical pedagogy the present problem is one of adjustment to modern conditions. This demands for its general solution a wide outlook over the history of the past as well as an intimate knowledge of the needs of the present. The routine of teaching too often proves fatal to this breadth of view, leading the teacher into the error of measuring his success by the facility acquired by his pupils in the subject taught. The true criterion of success in instruction is whether or not it leads the pupil to his highest individual development, refining his spirit and enlarging his field of usefulness. Like other fine arts, teaching can never be made amenable to fixed rules and rigid methods. There are, however, certain general underlying principles which distinguish the art from pure caprice, and

of these the historical method of presentation is fundamental.

S. E. SLOCUM

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SCIENTIFIC BOOKS

A Student's Manual of a Laboratory Course in Physical Measurements. By Professor W. C. SABINE. Ginn & Co. 1906. 8vo, pp. 97.

A Text-book of Practical Physics. By W. WATSON. London, Longmans, Green & Co. 1906. 8vo, pp. 626.

Elementary physical laboratory work in American universities has to fulfill two requirements, namely, to complement the first lecture course in general physics and to teach accuracy of observation. While it is desirable that the number of experiments to be performed should not be too limited, the characteristic value of physics as a culture study lies in the training of accuracy of expression and observation. In order to enable the student to perform a sufficiently large number of experiments—which is unfortunately often made the test of ability—and to give him the necessary training in accuracy, it has become the custom to describe only those exercises which he is expected to perform, and avoid a possible "waste of time" by rather minute descriptions of apparatus.

The selection of a few out of a large number of instructive experiments is always a difficult task and will lead to a different choice, according to the tastes of the author and the equipment of the school in which the book is to be used.

Sabine's well-known manual which has now appeared in its second edition shows this elasticity of selection in the omission of many exercises found in the former edition and the introduction of several new ones. Their number has been reduced from about seventy to thirty. Mechanics has practically remained unchanged. In sound a qualitative experiment, "Quality by the manometric flame," has been added. All the former experiments in heat have been omitted and a single one substituted for them, namely, "the determination of the mechanical equivalent of heat." Without questioning the great importance of this exercise it seems to the reviewer that some of the discarded experiments, as "specific heat, heat of fusion, or expansion" are better adapted, at least for an elementary course which is expected to teach only the rudiments of physical manipulations. In light also important changes have been made. "Equivalent focal length of compound lenses" takes the place of several exercises on radii of curvature and focal length of mirrors and lenses. "Wave-length of light by Newton's rings and the diffraction grating," also "Rotation of polarized light" are new. In the electrical part a good descriptive chapter on galvanometers adds much to the value of the book. The work with cells (internal resistance, different arrangement of cells, etc.) has been considerably condensed and an experiment with the dynamo added.

On the whole the changes made for the new edition are good; each exercise illustrates an important principle and a repetition of the same in other parts of the book has been carefully avoided. The instructions given for each experiment are more specific than in the first edition, but this has not been carried so far as to prevent a certain independence of the student and a possible variation of the apparatus used in the course.

Watson's "text-book" is of an entirely different character. It is more of the nature of Kohlrausch's "Leitfaden" and contains nearly 200 experiments. An introduction of forty pages treats of general methods used in the reduction and discussion of the results of physical measurements, and an appendix of twenty pages contains short practical information as to glass blowing, work with fused quartz, silvering glass, mounting of cross wires in telescopes and microscopes and the use of manganin wire for the construction of standard coils.

The book is intended for students who "have already spent a little time in the laboratory," and for such it is an excellent refer-

ence book with its wealth of information and the emphasis laid upon influences of errors. It is, of course, not expected that any class should work through all the experiments described, but that the teacher will make a selection from them.

The book is distinctly for undergraduate instruction, including the most elementary exercises given in any physical laboratory. Probably on account of its elementary character no measurements of dielectric constants and no experiments in atmospheric electricity or with electric waves are given.

While a manual of the "American" type, as Sabine's, seems more suited for beginners in laboratory work, especially in our colleges where large classes must be handled by one instructor, Watson's text-book would be particularly suited for a course in which not all time is spent in practical work, but where some collateral reading is required. Any student specializing in physics ought to be acquainted with the contents of the book.

K. E. Guthe

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SOCIETIES AND ACADEMIES

SOCIETY FOR EXPERIMENTAL BIOLOGY AND MEDICINE

Twenty-second Meeting

The twenty-second meeting of the Society for Experimental Biology and Medicine was held at the Rockefeller Institute for Medical Research, on Wednesday evening, April 17. The president, Simon Flexner, was in the chair.

Members present—Auer, Beebe, Burton-Opitz, Calkins, Carrel, Emerson, Ewing, Field, Flexner, Gibson, Gies, Hatcher, Kast, Levene, Loeb (L.), Meltzer, Morgan, Noguchi, Richards, Salant, Shaffer, Teague, Torrey, Wadsworth, Wallace, Wolf, Wood.

Members elected—R. R. Bensley, William T. Councilman, Ludwig Kast, Waldemar Koch, W. J. MacNeal, F. P. Mall, T. Brailsford Robertson, Oscar Teague, Richard Weil.

Abstracts of the Communications[2]

Wounds of the Pregnant Uterus: Leo Loeb.

Experiments were carried out on twenty-six guinea-pigs at different stages of pregnancy. Wounds were made in various directions in the uterus, or part of the wall of the uterus was inverted so that the mucous membrane was turned outside. It was found that at a certain stage of pregnancy, namely, from the fourth to the sixth day, nodules of decidual tissue were formed at places where the continuity of the uterus had been interrupted or where the mucous membrane had been inverted. Serial sections of these nodules showed that they consisted of typical decidual tissue, which did not include a developing ovum. Between the third and fourth weeks after impregnation, such nodules became necrotic.

These experiments were also of interest in seeming to show that under ordinary conditions it is not possible to produce an abdominal pregnancy in the guinea-pig by various injuries of the uterus.

The Effect of Light on the Staining of Cells: Leo Loeb.

In solutions of dyes (neutral red, eosin, methylene blue, methyl violet and others), cells (eggs of Asterias) are stained differently, according to whether the cells and solutions are exposed to the light or kept in the dark.

The difference in the staining of cells in the light and dark is caused by at least two different effects of the light. (*a*) The light causes primary changes in the cells, and the difference in the staining of cells in the light and in the dark is caused by those primary changes which the light produces in the cells. This applies to staining with eosin, neutral red, and with certain mixtures of eosin and methylene blue, and eosin and neutral red. (*b*) The light changes primarily the staining

[2] The abstracts presented in this account of the proceedings have been greatly condensed from abstracts prepared by the authors themselves. The latter abstracts of the communications may be found in Number 5 of Volume IV. of the society's proceedings, which may be obtained from the secretary.

solutions and the staining of the cells corresponds to the primary changes in the staining solution. This applies to staining with pure methylene blue and to such mixtures of methylene blue and eosin as contain much methylene blue. It also applies, perhaps, to solutions of hematoxylin. The staining of the cells in the light as well as in the dark depends also upon the proportions in which both dyes are present in the mixture.

It is possible to distinguish the two factors stated under *a* and *b* by killing the cells with heat. The effect of light upon the cells which is caused by its direct action upon them, disappears if the cells have been previously killed. The changes, on the contrary, which are secondary to the primary changes in the staining solutions still occur.

Means which diminish the oxidative processes in the cells (*e. g.*, addition of KCN) and also saturation of the solution with oxygen, do not modify markedly the differences in the staining of the cells in the light and in the dark.

The Abolition of Visceral Pain by Intramuscular Injection of Cocaine: a Demonstration: LUDWIG KAST and S. J. MELTZER.

It was shown that the intestines of a normal dog under slight ether anesthesia were not devoid of the sensation of pain and that cocaine (intramuscular injection) abolished the pain through a remote anesthetic effect.

The Effect of Nephrectomy upon the Toxicity of Magnesium Sulphate when given by Mouth: a Demonstration: S. J. MELTZER.

It was shown that in nephrectomized rabbits, magnesium sulphate produces a profound general effect even when given by mouth, and that the absence of such an effect after the usual administration of the compound is due to the comparatively prompt elimination through the kidneys of a large part of the absorbed salt, thus preventing at any given time the accumulation within the organism of a quantity equal to a toxic dose.

Observations on a Rabbit for Thirty Months after the Removal of the Superior Cervical Ganglion: S. J. MELTZER.

The left superior cervical ganglion of a full-grown gray male rabbit was removed October 14, 1904. The animal died April 23, 1907. During the last eighteen months of its life *the blood vessels of both ears were never very wide and showed but little of the usual rhythmical changes.*

After removal of the ganglion, a subcutaneous injection or an instillation of adrenalin into the conjunctival sacs of the rabbit caused dilation of the pupil on the side from which the ganglion was removed. *This biological test for the absence of the ganglion* was frequently made within the two and a half years of the animal's life and it was found that a *subcutaneous or intramuscular injection or an instillation of adrenalin invariably caused a long lasting dilation of the left pupil.* In further harmony with this proof that the ganglion was not regenerated, or at least the post-ganglionic and preganglionic nerve fibers did not grow together, it was found that while stimulation of the right sympathetic easily caused the usual effects upon the ear vessels and pupil of the corresponding side, *stimulation of the left cervical sympathetic caused no changes whatever in the left pupil or in the vessels of the left ear.*

During the last twelve months of the rabbit's life, the dilation of the left pupil never attained the same degree as during the earlier period. Further, an intramuscular injection of adrenalin, which in the early period caused dilation of the pupil within two or three minutes, lately developed its effect very slowly. Finally the constricting effect of eserin was only partly overcome by an injection or instillation of adrenalin, whereas in the early period the effect of eserin was completely overcome by adrenalin.

Within the last ten months the *right pupil was permanently distinctly larger than normal and responded sluggishly to light. An injection of adrenalin caused a distinct constriction,* which lasted about fifteen minutes. After the above-mentioned stimulation of the cervical sympathetics, *the permanent dilation of the right pupil disappeared for about five weeks and an injection of adrenalin had no effect upon the pupil.*

At the autopsy, no sign of a ganglion could be discovered on the left side.

Intra-abdominal Pressures: HAVEN EMERSON.

In dogs the pressure varied from 2 to 45 mm. of water above atmospheric, *i. e.*, positive; in cats from 2 to 20 mm. positive; in rabbits from 2 to 25 mm. positive; in calves from 2 to 10 mm. positive.

The causes of this persistent but fluctuating positive pressure within the free peritoneal cavity are the tone of the muscular walls of the peritoneal cavity, including the diaphragm and the pelvic floor. The contraction of the diaphragm is the chief, if not the only factor in the normal rise in pressure during inspiration.

Debilitated states show a low pressure. Ether anesthesia causes a gradual drop in pressure until, with complete loss of muscular tone, the pressure reaches zero. Curare likewise causes a progressive fall to zero pressure. Asphyxia develops great rises in pressure during inspiration until muscular relaxation allows a drop to zero just before death.

Excessive pressure artificially produced within the peritoneal cavity causes death from cardiac failure before the obstruction to respiratory excursion has developed a marked asphyxia. The pressure is the same at all points of the peritoneal cavity, and is subject to identical variations wherever the recording trocar is placed.

The physiological function of these pressure conditions seems to be chiefly in assisting the circulation of blood and lymph, thereby playing an important rôle in the processes of absorption and elimination, which take place within the abdomen.

On the Influence of CO_2 on the Viscosity of the Blood: RUSSELL BURTON-OPITZ.

The dogs used in these experiments received alternately a supply of normal air and air charged with CO_2. During the period of inhalation of the air plus CO_2 the arterial blood showed a somewhat greater viscosity than during the time when the animal breathed normal air. The changes appeared very promptly, but were never very conspicuous. The specific gravity of the blood pursued a course parallel to that of the viscosity.

Agglutinins and Precipitins in Anti-gonococcic serum: JOHN C. TORREY.

Rabbits and other laboratory animals, when inoculated with cultures of gonococcus, raise specific agglutinins and precipitins.

Normal rabbit serums contain different amounts of agglutinin for gonococcus. Strains of gonococci differ greatly in the titer of their agglutination with various gonococcic immune serums. After one inoculation with a certain culture, a large amount of agglutinin was produced for some strains, but none for others.

Absorption experiments indicate that an anti-gonococcic serum may contain, in addition to the specific homologous agglutinins, several groups of agglutinins which act on the different cultures quite independently of one another. At least three groups were found, whose major or specific agglutinins are not removed by inter-absorptions. This indicates that as far as agglutination is concerned, there are specific differences between these groups. The family gonococcus is, accordingly, heterogeneous rather than homogeneous, and in that respect resembles the dysentery, colon and streptococcus families. In making a serum for therapeutic purposes, this fact should be borne in mind.

The passage of a culture of gonococcus through a guinea-pig caused a very marked decrease in its agglutinability. With the exception of one serum, meningococcus agglutinated only in low dilutions of the anti-gonococcic serums.

Anti-gonococcic serum contains specific precipitins for gonococcus. There appeared to be no relation between the precipitating and the agglutinating properties of an anti-gonococcic serum for a culture of gonococcus.

Anti-gonococcic serums contain, as a rule, some precipitins for meningococcus, but none for *m. catarrhalis* or *staphylococcus*.

There is evidence of a relationship between gonococcus and meningococcus, but not of as close a one as has been described by some investigators.

On the Separate Determination of Acetone and Diacetic Acid in Diabetic Urines: OTTO FOLIN.

Measure 20–25 c.c. of acetone solution or urine into an aerometer cylinder and add 0.2–0.3 gm. of oxalic acid or a few drops of 10-per-cent. phosphoric acid, 8–10 gm. of sodium chloride and a little petroleum. Connect with the absorbing bottle (as in the ammonia determination), in which has been placed water and 40 per cent. KOH solution (about 10 c.c. of the latter to 150 c.c. of the former) and an excess of a standardized solution of iodine. Connect the whole with a Chapman pump and run the air current through for 20–25 minutes. (The air current should be fairly strong, but not as strong as for the ammonia determination.) Every trace of the acetone will now have been converted into iodoform in the receiving bottle. Acidify the contents of the latter by the addition of concentrated hydrochloric acid (10 c.c. for each 10 c.c. of the strong alkali used) and titrate the excess of the iodine, as in the Messinger-Huppert method, with standardized thiosulphate solution and starch.

The estimation of the acetone can be made simultaneously with the determination of the ammonia, by the use of the same air current and even in the same sample of urine, but the author does not recommend such simultaneous determinations except for cases where the amount of available urine is small.

On Magnesium and Contractile Tissues: PERCY G. STILES.

The author extended and confirmed the findings of Meltzer and Auer. Magnesium was found to have a direct inhibitory effect on automatic tissue (plain and cardiac muscle) and a depressing effect upon the irritability of the non-automatic striped muscle. This influence is slow to wear off after the application, but seems generally to favor the longer activity of the muscle—in other words, it is conserving in character. Magnesium appears to be the element to which we may look with most reason when seeking an agent that shall suspend katabolic changes without permanently damaging living structures. It is clearly less hurtful than potassium in like concentration. Comparison of magnesium with potassium shows that the former is not so distinctly the antagonist of calcium as is the latter. It also seems probable that the power to mediate vagus inhibition, which Howell fixed upon potassium, is a unique property of that element and not shared by magnesium.

On the Extracellular and Intracellular Venom Activators, with Special Reference to Lecithin, Fatty Acids and their Compounds: HIDEYO NOGUCHI.

Calcium chloride stops venom hemolysis caused in the presence of oleic acid or soluble oleate soaps, but not that induced by lecithin. In the majority of serums, including those of man, horse, guinea-pig, rabbit, cat, rat, hen, pigeon and goose, there exist greater or less amounts of venom activators, and they can be completely inactivated by calcium chloride. Judging from the fact that lecithin in an available form is not affected by this salt, it is not likely that these serums owe their venom activating property to lecithin. As these activators are also extractable with ether they probably are nothing else than certain fatty acids, and, probably, soluble soaps. Dog's serum offers an exception to this, and contains, besides fatty acids and soaps, also activators of the nature of lecithin, for calcium chloride fails to stop completely its venom activating property. This lecithin-like activator is not extractable with ether, but is precipitable together with the serumglobulin by half saturation with ammonium sulphate. While the serum globulin falls out as a precipitate during dialysis, this activator remains in the solution, from which a large percentage of lecithin is extractable with warm alcohol. In many respects this appears to be a protein compound of lecithin and possibly is identical with Chabrie's albumin, which seems to be absent from the majority of normal serums, which develops in any serum heated to coagulation, and which renders all serums equally venom activating. Ovovitellin is another form of protein compound containing lecithin in available form

for venom. On the other hand, pure serum globulins or serum albumins are not venom activating, notwithstanding their content of alcohol-extractable lecithin. Non-activating serum can be made activating by adding small quantities of oleic acid or oleate soaps.

The degrees of susceptibility of corpuscles are parallel to the amounts of fatty acids which they contain. The absence of fatty acids is associated with total insusceptibility of the corpuscles to the hemolytic agent of venom. The amounts of lecithin extractable from corpuscles are about the same in different bloods and bear absolutely no relation to susceptibility. The addition of adequate amounts of calcium chloride stops venom hemolysis with washed corpuscles of susceptible species. A previous addition of a small amount of lecithin annuls protection by this salt. A small amount of oleic acid or soluble oleate soap, which is insufficient to produce hemolysis alone, can render the corpuscles of insusceptible species hemolyzable by venom. An oily substance can be extracted with ether from the stoma of susceptible corpuscles, but not from the insusceptible varieties. This oily mass is venom-activating, but contains no lecithin.

On the Influence of the Reaction, and of Desiccation, upon Opsonins: HIDEYO NOGUCHI.

The author found that opsonins were most active in neutral liquids. An alkalinity exceeding $n/20$ KOH prevented opsonization. An acidity of $n/30$ HCl was sufficient to stop the opsonic function of serum. Neutralization of excessive alkalinity or acidity caused reappearance of opsonic activity. On the other hand, an alkalinity or an acidity approaching that of the normal alkali or acid produced a condition of irreversibility of the inactivation. The opsonic index, estimated in the normal alkaline reacting serum, was far lower than that in a neutral medium.

The high stability of opsonins against desiccation and the high thermostability of dried opsonins are very striking. Almost no reduction of opsonic strength is evidenced after a serum is completely dried at 23° C. within a few hours. In the dry state, opsonins are well preserved even after two years. Temperatures below 150° C. do not destroy opsonins in the dry state. After heating at 150° C., dry serum becomes difficult to dissolve, but opsonins may still be detected in it.

Complements withstand desiccation and dry heat in a manner similar to the resistance of opsonins.

On Decomposition of Uric Acid by Animal Tissues: P. A. LEVENE and W. A. BEATTY.

In these experiments uric acid was subjected to the action of spleen pulp in the presence of 2-per-cent. of ammonium hydroxide and 2 per cent. of acetic acid. Under both conditions 50 per cent. of the uric acid present was decomposed. Allantoin was one of the decomposition products.

On the Diuretic Action of Thymin: P. A. LEVENE.

The experiments were carried out on a dog with an Eck fistula. The dog had been kept on a purin free diet many weeks before the experiment was begun. For three weeks preceding the experiment the water consumed by the dog and the urine eliminated were carefully measured. It was noted that administration of thymin was followed by marked diuresis.

On Lysinglycyl obtained in the Tryptic Digestion of Egg Alumen: P. A. LEVENE and W. A. BEATTY.

In the process devised by the writers a year ago for preparing the peptid, prolinglycyl, a substance was produced from egg albumen, which, on further cleavage, yielded only lysin and glycocoll. The substance could not be crystallized. The authors called attention to the fact that peptids of the hexon bases obtained by Fischer and Suzuki synthetically also failed to crystallize.

WILLIAM J. GIES,
Secretary

DISCUSSION AND CORRESPONDENCE

THE PARASITISM OF NEOCOSMOSPORA—INFERENCE VERSUS FACT

IN May of last year an article by Howard S. Reed, now of the Bureau of Soils, United States Department of Agriculture, appeared in SCIENCE (page 751), entitled "The Parasitism of Neocosmospora," this being made up largely out of a bulletin soon after published by the Experiment Station of Missouri. The article in SCIENCE and the bulletin are based on some confessedly incomplete work (bulletin, page 64) done at the University of Missouri with a *Fusarium* isolated from diseased ginseng plants. The contribution in SCIENCE is occupied chiefly with a criticism of some of my own conclusions published several years ago in a Department of Agriculture bulletin. This tardy reply is due to the fact that I have only recently read the article.

My first thought was that I must go all over my own work to see how I could have fallen into such an absurd error. On consultation, however, with one of my colleagues, who has been much engaged in recent years with diseases of this class, I found he had saved me this labor. Also on a second more careful reading of Dr. Reed's article in SCIENCE, and especially on reading his bulletin, I found so many unwarranted inferences that it seemed hardly worth while to consider his criticisms seriously. However, as his statements have entered into literature with the same face value as my own, especially for those who do not look into scientific writings very closely, I am compelled to make this answer.

I am not specially interested one way or another in the ginseng fungus as such. It may be a weak facultative parasite entering exclusively through wounds made by other fungi, as Dr. Reed asserts; although nothing in his writings clearly establishes this fact. The points at variance between us will be better understood if I first summarize the author's actual facts and then his inferences.

First as to the facts or supposed facts.

1. He found a *Fusarium* wilt of ginseng and also an anthracnose of ginseng. He states that wilting ginseng plants in all cases were previously attacked by the stem anthracnose, and further that the *Fusarium* entered the ginseng plants exclusively through stem-wounds made by this anthracnose.

2. He states further that on inoculating soils with the ginseng fungus, which soils were then planted with watermelon-seeds, he obtained a wilt of the melon-seedlings and found a *Fusarium* inside the stems (one experiment, three pots). Ginseng fungus, perhaps (?). When, however, he sterilized the soil in the autoclave and then inoculated it with his fungus and planted watermelon-seeds in it, the seedlings remained healthy for twelve weeks, although the fungus (ginseng fungus, be it remembered) grew abundantly in the soil.

3. He sprayed a "thoroughly underdrained" field of ginseng with Bordeaux mixture, and neither disease appeared in it. The *Fusarium* wilt appeared in a neighboring unsprayed field, which, however, belonged to another man and was not underdrained. From this he concludes that Bordeaux mixture is a remedy for the disease.

Some of the inferences I think unwarranted are the following:

1. The ginseng-fungus belongs to the genus *Neocosmospora.*

2. This ginseng-fungus and the watermelon-fungus first described by the writer as *Fusarium niveum* are identical.

3. The watermelon-fungus can enter the plant only when a way has been opened for it by other fungi, *e. g.*, by *Thielavia.*

4. Other *Fusaria* are in the same case. My conclusions, therefore, respecting the parasitism of the melon-fungus and similar forms for which I made the genus *Neocosmospora,* are erroneous.

This sufficiently outlines the points of difference between us.

Before passing to the manifest inferences, it may be remarked that neither from the article in SCIENCE nor from Dr. Reed's bulletin can it be concluded with any certainty how his fungus enters the plant (bulletin, page 50), or whether, as he asserts, spraying

with Bordeaux mixture will prevent the disease, either acting directly or indirectly. He states that the ginseng fungus is a wound parasite, but, so far as I can see from any facts advanced, this is only an assumption which may or may not be true. I should like to know whether this is entirely a *post hoc* conclusion or something which was actually demonstrated, and if so, how demonstrated, and why he has not published his proofs? He nowhere says that he actually found the *Fusarium* entering the plant through wounds in the stem caused by the anthracnose, although this, from the standpoint of his hypothesis, was one of the first things to look for and to be made out *conclusively*, not *inferentially*, especially if he proposed to use it as a basis for criticism.

To come now to those things which relate specially to my own work and are manifestly unwarranted inferences:

1. How does he know that the organism he worked with belongs to the genus *Neocosmospora?* He states distinctly that he did not find any perithecia. We know that not all members of the form-genus *Fusarium* belong to *Neocosmospora*, and also that inspection of the imperfect stages does not suffice to tell. This then is an uncertain inference put forward as a fact.

2. How does he know that his identification of the ginseng-*Fusarium* with the watermelon-fungus is correct? I doubt it. He did not make any comparative study of the two fungi, although it would have been easy for him to obtain the melon-fungus, since the disease is widespread in the southern United States, and probably occurs in Missouri, possibly in some of the soils he worked with. Why did he not make comparison between the two organisms rather than between his organism and my description?

3. How does he know from his very limited experiments with one species that all *Fusaria*, and the *Neocosmosporas* in particular, are weak parasites? He states that he found the ginseng fungus to be a weak parasite, but I have just pointed out that even this is not established conclusively from his papers. How, then, can the much larger inference be sustained? One can not reach general conclusions from a single particular. It does not need any very extensive course in logic to convince one of this.

4. How can inferences of any value respecting this group of fungi be based on such a sandy foundation? From his statements the reader is led to think that the watermelon fungus must be a weak parasite and that the plant must first be attacked by *Thielavia basicola* or some other fungus before the *Fusarium* can possibly find an entrance into it, although Dr. Reed probably never saw the melon-fungus, and has not *proved* that the ginseng-fungus can not enter the plant in the absence of wounds.

When this paper of Dr. Reed's first came out, I was in Europe, but my colleague, Mr. Orton, obtained cultures of the ginseng-fungus from Dr. Reed and carefully compared it on various culture media with the watermelon-fungus which we had in culture in the laboratory, and found that they behaved differently and were probably not identical organisms. This is the sort of work Dr. Reed ought to have done and not left for some one else to do.

Mr. Orton also made in one of our hothouses the following three sets of inoculation experiments, using autoclaved soil:

1. Watermelon-plants; the soil inoculated with the ginseng-*Fusarium*, obtained from Dr. Reed. Ten inoculated pots and ten control pots.

2. Watermelon-plants; the soil inoculated with the cotton-*Fusarium*. Ten inoculated pots and ten control pots.

3. Watermelon-plants; the soil inoculated with the watermelon-*Fusarium*. Ten inoculated pots and ten control pots.

The results were as follows:

1. No cases of melon-wilt in the pots inoculated with the ginseng-organism. (Experiment agrees with Dr. Reed's corresponding experiment.)

2. No cases of melon-wilt in the pots inoculated with the cotton-organism. (Experi-

ment agrees with Smith's earlier statements; Bulletin 17.)

3. Typical watermelon-wilt in the pots inoculated with the watermelon-*Fusarium*. All of the ten plants growing in this autoclaved soil contracted the disease. They were watered with distilled water until the plants began to develop the wilt, and then they were watered with ordinary hydrant water.

(4) All the uninoculated plants (30 pots) remained free from disease.

Because one fungus in a group is a feeble parasite, it does not follow that all are, and especially in the absence of experimental data. The writer never maintained that all species of the form-genus *Fusarium* were active producers of disease. In fact, when he began to study this group, all of them were supposed to be saprophytes, and he was, I believe, the first one to maintain and *to demonstrate* that certain members of the group are among our most destructive fungi. This work has been built upon largely in certain quarters, with very scant credit to the writer. Such matters, however, even themselves up in the long run and credit finally goes where it belongs.

The moral of all this is that when one assumes the rôle of critic he ought to be reasonably certain of his facts.

ERWIN F. SMITH

August, 1907

ENGLISH AS SHE IS WRITTEN

EVER since it was authoritatively decided that "The United States is," and not "are," there has been increasing departure from what was not long ago considered good grammar, especially in the newspapers. We do not expect the "dailies" to lead in correct diction, however desirable this would be from the fact that the reading of the bulk of our population is done in their columns, and serves the younger generations as their preferred literary food. We are so accustomed to having the papers pervert the nation's English that we rather expect to see all kinds of grammatical and syntactic horrors perpetrated in our morning papers. And SCIENCE could hardly be expected to bring much pressure to bear upon the journalistic world in inducing them, *e. g.*, to use the nominative instead of the accusative case when stating that "whom it is well known has been," etc., a form to be found in every daily for the last two or three years. But when SCIENCE, as well as some other journals of high standing, admits into its columns such statements as that "the underlying strata was a soft limestone," and that "this phenomena was closely observed by us," and that "we owe this data to the courtesy of Mr. ——," it does seem that the restriction of the scientific curriculum to so much language study as is provided for in the high schools is proving unfortunate. Perhaps the inauguration of the much-needed spelling reform, which is considered by some as obliterating important landmarks, has contributed to the feeling of linguistic irresponsibility on the part of juvenile specialists in particular. But would it not be proper to consider the correction of such palpable mistakes as part of the duty editors owe to the public; if only to prevent us from being charged with illiterate perversion of the language by our cousins across the Atlantic?

E. W. HILGARD

BERKELEY, CAL.,
August, 1907

[The proofs of SCIENCE are read each week by three professional proofreaders, and most, though unfortunately not all, grammatical errors are corrected. Errors such as those quoted by our correspondent are like infringements of the etiquette of polite society—they are especially dreaded; but they are minor matters, and may indeed be in the line of linguistic evolution. It must be admitted that the English language is used with greater correctness and skill by men of science in Great Britain than in the United States. This is probably due to the fact that English men of science come as a rule from a comparatively small class in which the use of correct English is a social tradition.—EDITOR.]

THE ARTIFICIAL PRODUCTION OF MUTANTS

IN SCIENCE for July 19 Professor T. D. A. Cockerell gives an appreciative review of Tower's "Investigation of Evolution in Beetles of the Genus *Leptinotarsa*," a recent

publication of the Carnegie Institution, and in a closing paragraph says:

> One of the truest tests of the intellectual status of a country is found in its ability to quickly realize the importance of a work of the first class. Since this book came out I have asked a number of naturalists whether they had read it, and so far have failed to find one who has given it more than superficial attention.

It had appeared to me for some time that botanists in the United States were in something the same case as the zoologists in regard, on their part, to the one successful series of demonstrations that have yet been made of the production of mutants of plant species by means of definite chemical stimuli. It was, therefore, a pleasure in reading SCIENCE for June 7 to find that Dr. James B. Pollock (presidential address before the Michigan Academy of Science) had clearly recognized the significance of recent experimental work with plants, which, perhaps, still more fully than Tower's work on beetles, has established the mode of origin of certain species. To quote from Pollock: "De Vries offers no explanation as to how these new characters are produced, but MacDougal has succeeded in producing new modifications by artificial means . . . injecting various substances into the capsules of plants experimented upon, before the eggs were fertilized," leading to the "important conclusion that in an early stage of development of the plant egg it may be so profoundly modified that the adult plant resulting from it is decidedly different from what it would have been had the egg not been so modified, and the modifications thus produced are transmitted to the next generation through the seeds."

With this very definite presentation of the subject I am disposed to assume that the work referred to is, after all, well known to botanists, but that thus far only here and there one has taken occasion to refer to it in generally accessible publications. Be this as it may, I wish to heartily second the efforts of Professor Cockerell in calling attention to the epoch-making character of Tower's experimental study of the potato beetles and their allies, and to place with them the equally important work of MacDougal, recording at the same time my conviction that there is no line of biological investigation, with which I am acquainted, that better deserves support or the abandonment of which would be a greater loss to science. I can hardly think, however, that the Carnegie Institution, one of the chief functions of which is to discover just such "leads" and provide for their following through to a successful issue, will abandon either of these investigations, already the most fruitful in actual results that have been undertaken since the "Origin of Species" appeared.

V. M. SPALDING

TUCSON, ARIZ.

SPECIAL ARTICLES

PATAGONIA AND ANTARCTICA[1]

IT seems that the study of the fossil fauna of South America should attract the attention of the congress, at this time when increasing efforts are being made to enter into touch with the problems of the antarctic world.

Since the discoveries of Carlos and Florentino Ameghino, numerous works on the fossil fauna of Patagonia have been published. We have been enabled to add some contributions to this literature from the rich collections sent by A. Tournoüer to the Jardin des Plantes.

Up to the present time, the researches in the northern hemisphere, whether in the United States or in Europe and Asia, have shown an agreement in the development of life. The progress of evolution has been so uniform that we find beings of the same epoch in almost the same stage of evolution on different parts of our hemisphere. Thus, from the stage of the development of fossil animals and knowing their genus or species, we can often estimate for geologists the age of the deposit (terrain) in which they are found.

Patagonia has just shown us that this is

[1] Paper read before the seventh International Zoological Congress, translated by L. M. F.

not the case in the southern hemisphere. The fauna of Casarmagu (or of Cerro Negro) is related to that of Torrejon and Puerco, about which the scientists of the United States have made some remarkable revelations, and also bears a resemblance to the fauna of de Cernay near Reims, discovered by the late Dr. Lemoine. The fauna of later epochs, the Deseado, Coli-Huapi, Santa Cruzian and Pampean, has not a single genus comparable to those on our hemisphere, and shows an arrest in the development. No mammal has become a paridigitate pachyderm, a ruminant, a soliped like ours, a proboscidian, a placental carnivore or an anthropoid ape. To be sure, the bones are homologous and many of them resemble the bones of our animals. But the association of the characters is very different. For example, in *Pyrotherium* the hind quarters resemble those of proboscidians, but the forelegs show an entirely different attitude. In limb structure *Astrapotherium* recalls the dinoceros of the United States, but its dentition is different. *Colpodon* and *Nesodon* differ less in their dentition from our Ungulata than from other animals, but they have carnivore limbs and their tridactyl hind foot is plantigrade. The gigantic *Homalodontherium* shows still better the association of ungulate and carnivore characters. Many more examples could be given showing to what extent the fossil mammals of South America are specialized and how little they resemble in appearance the fauna of the northern hemisphere.

This statement is of considerable importance to explorers of the antarctic world. When the Institute of France commissioned some of its members to collect information for the next voyage of Dr. Jean Charcot, I published a note in which I pointed out what they might expect to discover in Antarctica, judging from what we know of the paleontology of South America.[2]

I noted that the existence of the various large animals of Patagonia can not be accounted for in conditions analogous to the actual ones. In the Eocene period, the Deseado has powerful quadrupeds: *Pyrotherium, Astrapotherium, Homalodontherium, Colpodon, Palæopeltis* and many other herbivorous genera. This presupposes a luxuriant vegetation and hence a degree of warmth which is in marked contrast to the present cold climate. Furthermore, it presupposes an extent of territory very different from the present narrow space of Patagonia; for it is an admitted fact in zoology that the size of mammals is in direct proportion to that of their habitat. The fauna of Deseado and of Coli-Huapi, which came immediately after, can not be explained unless Patagonia is the remnant of a vast antarctic continent.

In the Miocene period appeared the fauna of the Santa Cruzien with its quantities of large *Nesodon, Astropotherium, Homalodontherium,* diversified Edentates and so forth. It is equally impossible to understand this fauna if it did not live on an antarctic continent.

In the period of the Pampas the terrestrial fauna became more powerful than all the former ones. *Megatherium, Mylodon, Lestodon, Scelidotherium, Glyptodon, Toxodon* and *Macrauchenia* in life size must have constituted one of the most imposing sights in the history of the world. This fauna is the most difficult of all to account for, if it did not live on an immense antarctic continent with a rich vegetation and warm climate. Since South America is only 1,000 kilometers from Antarctica, it is improbable that this region was at that time under ice and submerged. In his report of the expedition of the *Belgica,* Mr. Cook has written: "*The Soundings taken between South America and the South Shetlands and those made in Antarctica show clearly the existence of a continental plateau.*"[3]

Hence a determination of the age of the Pampas is of great importance for a closer knowledge of the antarctic continent; this

[2] Institut de France, Académie des sciences, "Instructions pour l'Expédition antarctique organisé par le Dr. Jean Charcot. Palæontologie," par Albert Gaudry, p. 19, 1907.

[3] Cook, "Kis le Pole Sûd, Expédition de la Belgica," 1897–9, p. 8.

should give us information about the time when the antarctic lands sank for the last time and became covered with ice.

The age of the Pampas is difficult to determine by means of the mammals indigenous to Southern America since they differ so much from those of our country that a comparison of the two teaches us nothing. However, among so many remarkable facts shown by the paleontology of the new world, one of the most singular is the invasion of the genera of the northern hemisphere, the Mastodons, *Hippidium*, tapir, llama, peccary, *Machairodus*, bear, etc., among the animals of the Argentine Republic which show an absolutely different physiognomy.

The best known of the new comers, *Mastodon Andium* is not quaternary in Europe nor in the United States. Cope found it in the Pliocene of Blanco, Texas. The *Mastodon angustidens* and *Pentelici* of the European Tertiary are not far removed from it.

Hippidium neogœum and the species of *Hippidium* with eye-pockets (?) known as *Onohippidium*, are more nearly related to the pliocene forms of our country (*Equus stenonis*), than to the Quaternary horses. Dr. Matthew has said: "*The teeth of Hippidium are like those of Phiohippus* (*upper Miocene*) *from which it is supposed to be descended.*"[4]

The genus Tapir, unknown in the quaternary, is well distributed in the European Pliocene; it might have sprung from *Tapiravus* of the upper Miocene.

In the simplicity of the dentition of its molars the peccary is an archaic type; it is found in the upper Miocene.[5]

The llama (*Auchenia*) is possibly derived from the *Pliauchenia* of the Pliocene of Blanco.

Machairodus, in the United States and in Europe, has left numerous tertiary remains. Mr. Boule has reported on the *Machairodus aphanistes* of Pikermi and *Machairodus neogœus*.[6]

Ursus bonariensis which has persistent præmolars and shortened molars differs less from the tertiary bear of our country than from *Ursus priscus* and *U. spelœus* of the quaternary.

If to these citations we add the fact that no elephant has appeared in Southern America, we may suppose that the invasion of the forms of the northern hemisphere took place in the pliocene and not in the quaternary. Dr. Osborn has pointed out recently that the invasion of the Edentates of South America and the migration of the North American mammalia into South America, was quite characteristic of the pliocene phase in the United States.[7] It is important to note that, according to the lists of fossils, divided into numerous stages by Mr. F. Ameghino, it is only from the time of the lower Pampéen that the animals of the north multiplied.[8] They are not present in the beds of Mt. Hermoso.

The greater part of the Pampéen beds are Pliocene, but this is no reason why the uppermost should not belong to the quaternary. Mr. Ameghino attributes the lowest beds of the Pampéen which he calls Lujanean (?) to this deposit (terrain). Now in these beds the American animal world shows still more strength, since the quadrupeds from the United States are there side by side with the gigantic animals born in the southern regions. If the age attributed to the Lujanean is correct we must conclude, from our remarks above, that, at the beginning of the quaternary, that is to say in the epoch when Man was living in Europe, the antarctic territory could not have been completely separated from America. It would not be impossible to find buried

[4] Matthew, "Illustrations of Evolution among Fossil Mammals," *Bull. Am. Mus. of Nat. Hist.*, Vol. III., Extr. 1903, p. 24.

[5] Blainville in his "Osteographie" has said that the peccary is the *Sus* with the simplest and most normal dentition.

[6] Boule, "Revision des espèces Européennes de Machairodus," *Bull. de la Soc. géol. de France*, 4[me] Séries, vol. 1, p. 572, 1901.

[7] Osborn, "Tertiary Mammal Horizons of North America," *Bull. Am. Mus. Nat. Hist.*, Vol. XXIII., p. 251, 1907.

[8] Florentino Ameghéne, "Les formations Sédimentaires du Crétacé Supérieur et du Tertiares de Patagonie," no. 8, pp. 480–498, Buenos Aires, 1906.

there *Megatherium, Mylodon, Macrauchenia, Hippidium, Mastodon* and many other quadrupeds. Mr. Otto Nordenskjöld has found tertiary plants there; remains of quadrupeds, will also be met with.

The Antarctic world offers a magnificent field for discovery to explorers.

ALBERT GAUDRY

QUOTATIONS

THE PHYSICIAN IN THE SCHOOL

THE International Conference on School Hygiene, held in London this month, raised many questions which should search the hearts of teachers, parents, and taxpayers in America. Some of these questions we have already been debating. In this city last winter Superintendent Maxwell urged that the eyes of school children be examined, and that glasses be provided—if necessary at public expense—for those whose sight is defective. The shortest way with such a proposal is to give it a bad name and damn it. Accordingly, the plan was received by a part of the press with jeers and cries of "Socialism!" Mr. Maxwell's reply was in effect that we are spending millions a year for teachers, buildings, text-books, and apparatus; and that it is worth while to lay out a little more in order to enable all the children to profit by these facilities. In an article in our own columns last April he said:

> It seems folly to supply books to children who can not read them, or to place children in classrooms when they can not see what is written or drawn on the blackboard. If the sight is defective, the child is hopelessly handicapped. The expenditure of a few thousand dollars for glasses would enable thousands of children who are now unable to do their school work to stand on the same level with their fellows.

These words sum up briefly the whole argument for the physical examination of school children and the attempt to keep them in such health that they can fairly avail themselves of the advantages offered. We can not dismiss the matter with a question-begging epithet. Our American school boards must consider the project on its merits, and decide whether, in justice to the children as well as to the community as a whole, we should not devote more attention to the physical well-being of pupils.—The New York *Evening Post*.

CURRENT NOTES ON LAND FORMS

OTAGO PENINSULA, NEW ZEALAND

OTAGO PENINSULA is a land-tied island on the east coast of southern New Zealand. An interesting account of its features is given by P. Marshall, professor of geology in Otago University at Dunedin, near the head of the Otago Bay, which the peninsula encloses. ("The Geology of Dunedin, New Zealand," *Quart. Journ. Geol. Soc.*, LXII., 1906, 381–424). The peninsula is a complex mass of volcanic rocks, which, while the district stood towards 1,000 feet higher than now, was submaturely dissected; that is, the valleys, still narrow and of rapid descent in their upper courses, became more open and of gentler descent in their middle and lower courses; and the slopes came to have only moderate declivity. During submergence to its present level, the mountainous mass was cut off from the mainland by the drowning of a connecting ridge on its northwestern side; it thus became an island, about 14 miles long northeast-southwest, and not more than six miles wide, with summits still reaching more than 1,000 feet above the sea, and with much irregularity of outline as would be expected. Since the district assumed this attitude, the exposed headlands, on the mainland as well as on the island, have been cut back in strong cliffs, from 300 to 800 feet high; the smaller reentrants have been filled with beach-fronted sands; the larger reentrants have been more or less completely enclosed by bay-mouth spits and bars; and Otago strait, as the original water passage back of the island might be called, has been closed at its southwest end, under the guidance of the prevailing long-shore current from the southwest, by a beach-fronted sand-isthmus, which converts the strait into a long bay. The southward direction of growth of several bay-mouth spits and reefs suggests that they are controlled by backset eddies, which sweep around the new-built shore lines between the projecting headlands in a direction opposite to that of the main, long-shore cur-

rent. Otago peninsula would thus in several respects resemble Banks peninsula, on the same coast farther north; for this is again a dissected and formerly insular volcanic mass with a ragged and cliffed outer shore line, now transformed into a peninsula not only by the flying northeast stretch of Ninety-mile beach, but apparently also by the forward growth of the fluviatile Canterbury plains in the sheltered waters back of the former island.

Marshall's account of Otago peninsula proceeds on the "two bites of a cherry" method of first describing the various surface features, and then explaining their origin. So cautious a method may be appropriated in treating land forms of uncertain origin; but its employment in so simple a case as this one would seem to indicate an undue consideration for those who even in this day need to have it explained that bays are half-drowned valleys. Much space might be saved if the peninsula were briefly described as having been submaturely dissected in a former cycle of normal erosion, and as, after a depression of towards a thousand feet, being now vigorously attacked by the sea on the new shore line which is already advancing towards maturity on its seaward side. It is a great advantage to the reader to have the essence of the story thus presented in condensed form at the outset; the details can then be easily apprehended in their proper relations as they are reached in further reading.

THE FAYÛM DEPRESSION, EGYPT

Imagine a series of strata, of which certain members, *J* to *P*, are 700 meters in thickness, dipping very gently to the northwest. Let the lower formation, *J*, be a resistant limestone, 30 m. thick; the next formation, *K*, a series of weak clays and marls, 70 m. thick; and the following members, *L* to *P*, a succession of alternately resistant and weak strata, 480 m. thick. Conceive the whole series worn down nearly to baselevel in a desert climate, thus producing a broad peneplain on which the beveled strata appear in belts trending northeast-southwest. Now let the peneplain be uplifted with a gradual slope to the north, so as to gain an altitude of 300 or 400 m. in the district here especially considered; and in consequence of this uplift imagine the barren surface to be dissected to a stage of maximum relief by the winds and occasional rains. The weak belt, *K*, will thus be irregularly excavated as a subsequent depression along the strike of the guiding formation; the depression will be bordered on the southeast by a structural or "dip" plain of the underlying limestone, *J*; and enclosed on the north by three cuestas, rising in ragged escarpments, *L, N, P*, and separated by broad steps, *M, O*. The upland beyond the highest escarpment will gradually descend far northward to the sea, younger and younger formations being crossed on the way; while in the opposite direction the rising plain of the underlying limestone cuesta, *J*, will presumably break off in a southeast-facing escarpment overlooking another subsequent lowland eroded on underlying strata; . . . and so on to the basement oldland.

The waste from the depression eroded on the weak belt, *K*, having been largely exported as dust by the winds, the floor of the depression will sink here and there in enclosed basins, which may be excavated even below sea level; and the basins will be separated by low residual portions of the weak strata, which will form what may be described as transverse barriers or ridges—there being as yet no technical name for such features. Along the eastern side of the district, toward which the uplifted peneplain may have had a faint slope, imagine an additional uplift by faulting or monoclinal bending; and along the trough thus defined let a large north-flowing river erode a mature valley through the desert. The western side of the valley will vary in height as it obliquely cuts the several cuestas; with the eastern side we are not especially concerned. While the main valley is worn down contemporaneously with the general dissection of the peneplain, the river happens, by lateral erosion, to wear through the first transverse barrier in the weak beds, *K*, that separates the valley from a neighboring subsequent basin; a branch of the river then flows into the basin and forms a lake; but as the river continues to

deepen its valley, it fails after a time to supply the lake, which thereupon disappears by evaporation; only to be formed again later when the river, having aggraded its valley, supplies an artificial canal that is led into the ancient lake-bed for irrigation, with the result of forming a small lake in the bottom of the depression.

Such, in generalized terms, is the impression gained from reading "The topography and geology of the Fayûm province of Egypt," by H. L. Beadnell (Survey Dept. Egypt, Cairo, 1905, maps, sections and fine plates). The river is the Nile. The north-sloping upland is "the great undulating high-lying gravelly desert-plateau which stretches with little change of character to the Mediterranean" (p. 15). Its southern margin is the uppermost escarpment (*P*), Jebel el Qatrani, capped with basalt, which supplies a black talus to the slopes below; it is in these slopes and in those of the next lower escarpment (*N*), that the strata have recently (1901) been found to contain numerous mammalian fossils, for which Osborn's American Museum party has recently searched (see Science, March 29, 1907). Where the Nile valley cuts the next cuesta (*L*), the corner of the escarpment stands forth in a commanding bluff, Elwat Hialla, from which one may gain a broad view up and down the river, with Cairo and the Pyramids in the north, the yet higher escarpment of the uplifted desert plateau on the east, and the first of the subsequent basin-depressions to the southwest, holding the oasis of the Fayûm, watered by the Bahr el Yusef from 200 kil. up the Nile, and the shallow lake, Birket el Qurun, some 40 kil. long, with its bottom about 50 m. below sea-level; while the dip plain of the lower limestone (I, Eocene) ascends slowly in the southern distance. In ancient historic times, the depression contained the much larger Lake Moeris, which then served to regulate the flow of the lower Nile; and in still earlier, pre-historic times here stood a similar lake, now recognized by its silts. Additional small basins occur farther southwest. Still farther away in the same direction, the weak strata rise to "the ordinary desert plateau, on which the outcrops of the beds of successive rock stages follow one another in regular order from south to north, but without forming well-marked topographic features" (p. 27): it is on the strength of this brief statement regarding the beveling of the rock series that we have inferred the (Miocene) peneplanation of the region; possibly an insufficient foundation for a broad generalization. The winds are still effective agents of erosion and transportation; rock ledges are described as wonderfully carved by sand blast (p. 85); and long sand-dune windrows are common, a remarkable one being shown in plate XV.; nevertheless, the occasional action of wet-weather streams is evidently dominant in determining the details of the ragged escarpments, which repeat bad-land forms, familiar in our western country.

Whether the generalized statement given above is correct or not, it is not easy to say; for translations from the topographic description of an observer acquainted with the ground, into systematic physiographic description by a reviewer who has not seen the ground, is admittedly difficult. There need be no question as to the stratigraphic sequence, for that is set forth in the systematic fashion of established geological terminology; but the topographic features produced by the work of desert erosion are not described in terms of standardized type forms, hence the translation from empirical to systematic language is somewhat uncertain.

Shall the linear depressions and reliefs of the Fayûm basin and the escarpments to the northwest be called "vales" and "wolds," as suggested by Veatch (see these notes for June 14, 1907)? The ragged escarpments of the cuestas have no likeness to the softly rounded forms of the Lincolnshire and Yorkshire "wolds"; and the barren misery of the unirrigated desert depressions is strongly at variance with the connotation of an agreeable landscape, usually suggested by "vale."

THE ARID CYCLE IN EGYPT

H. T. Ferrar, lately of the British Antarctic expedition and now of the Geological

Survey of Egypt, briefly inquires under the above title (Survey Notes, Cairo, 1906, 18–20), whether the deserts bordering the Nile offer illustrations of "the geographical cycle in an arid climate" (see *Journ. Geol.*, xiii., 1905, 381–407), and suggests that forms in various stages of arid development are recognizable at many localities. He offers a number of examples of independent basins with local centripetal drainage, which are taken to represent the youthful stage of the arid cycle. "Most members of the Geological Survey [of Egypt] have shown that the Nile valley was once occupied by a series of fresh-water lakes in which calcareous travertine and other lacustrine products were deposited"; but the brief text does not suffice to show whether these basins were "initial," that is, due to inequalities in the originally uplifted land surface, or whether they were due to the long-continued desert erosion of such a surface, the basins being temporarily occupied by lakes during a moist climatic epoch of brief duration. The probability of the survival to-day of any initial basins in the region of the Nile is contradicted by the evidence of long-continued erosion presented in the preceding note. Examples of the disintegration of drainage, supposed to be characteristic of an advanced stage of the arid cycle, are also instanced by Ferrar; but the disintegration here noted is due to obstruction by invading sand dunes, and not to the excavation of shallow basins by wind action, as suggested in the general scheme of the arid cycle.

The interest thus manifested in the physiographic study of desert forms leads us to hope that their detailed and systematic description may be forthcoming in the publications of the Egyptian survey; but the possibility of finding, even in the deserts that border the Nile, the results of arid erosion, not dominated by the occasional action of flooded streams, is made improbable by the account of the sudden rain-floods ("seils") given by H. G. Lyons, director general of the survey department of Egypt in his admirable report on "The physiography of the River Nile and its basin" (Cairo, 1906). A few local rainstorms occur every winter east of the Nile, where the slope from the desert plateau toward the river is well marked. "In about every second year one or other of the larger wadies comes down in flood, sometimes so suddenly as to carry away camels and sheep. . . . Their effect in eroding the desert is immense. . . . These 'seils' are less rare than is usually supposed, and the dry arid appearance of the desert, together with the rareness of rain, cause the effect of such storms as do occur to be underestimated." Yet on the lower desert upland west of the Nile, it appears that the occasional rainfall "drains into shallow wind-worn depressions and there soaks into the rock or is soon evaporated" (p. 293, 294).

The reviewer finds difficulty here, as in the preceding note, in the attempt to translate a general descriptive account into a systematic account, in terms of structure, process and stage. W. M. D.

INTERNATIONAL CONFERENCE ON PLANT HARDINESS AND ACCLIMATIZATION

An important conference will be held under the auspices of the Horticultural Society of New York on October 1, 2 and 3 in rooms of the American Institute and the Museum building of the New York Botanical Garden.

The preliminary list of papers to be presented is as follows:

D. T. MacDougal, Tucson, Ariz.: "The Determining Factors in the Seasonable Activity of Plants."

Henry C. Cowles, University of Chicago: "Factors that control Acclimatization."

B. L. Livingston, Tucson, Ariz.: "Evaporation as a Climatic Factor influencing Vegetation."

Ernst A. Bessey, Subtropical Laboratory, Miami, Fla.: "Air Drainage as affecting Hardiness of Plants."

Frederic E. Clements, University of Nebraska: "The Real Factors in Acclimatization."

W. M. Hays, Assistant Secretary of Agriculture: "Plant Improvements needed in Specific Cases."

J. C. Whitten, Missouri: "Comparative Hardiness of Plants of the same Variety from Northern and Southern Points."

M. Robert, Algeria: "Observations on Eucalyptus Hybrids; The Japanese Loquat in Al-

geria; Truth to Seed of Eastern and African Varieties of *Vitis vinifera.*"

D. W. May, Porto Rico: "Temperate Zone Plants in the Tropics."

D. Morris, Imperial Department of Agriculture for the West Indies: "Acclimatization of Economic and other Plants in the West Indies."

H. L. Hutt, Guelph, Canada: "Cooperative Testing to ascertain Hardiness in Fruits."

T. V. Munson, Texas: "Resistance to Cold, Heat, Wet, Drought, Soil, etc., in Grapes."

Samuel B. Green, Ohio: "Developing Hardy Fruits for the North Mississippi Valley."

U. P. Hedrick, Geneva, N. Y.: "Hardiness of the Peach."

O. M. Morris, Oklahoma: "Hardiness of Apples."

W. S. Thornber, Washington: "Fruits and Trees in the Northwest."

B. C. Buffum, Wyoming: "Hardiness and Acclimatization of Alfalfa."

S. Fraser, Geneseo, N. Y.: "Some Work with Timothy and Awnless Brome Grasses."

Anthony U. Morrell, Minnesota: "Hardiness of Ornamental Plants in the Middle Northwest."

L. H. Pammel, Iowa: "Studies on the Acclimatization of Plants in the Prairie Regions."

Jens Jensen, Chicago, Ill.: "Observations in the Region at the Head of Lake Michigan."

Walker H. Evans, U. S. Department of Agriculture: "Experiments in Plant Acclimatization in Alaska."

D. F. Franceschi, Santa Barbara, Cal.: "Fifteen Years' Experience in Southern California."

Andrew J. Soule, Blacksburg, Va.: "Some Experiences with Field Crops in Virginia."

Geo. V. Nash, New York Botanical Garden: "Observations on Hardiness of Plants cultivated at the New York Botanical Garden."

W. Trelease, Missouri Botanical Garden, St. Louis, Mo.: "Some Anomalous Observations in St. Louis."

J. E. Higgins, Hawaii: "Problems of Hawaii."

THE BRITISH MUSEUM

The return giving the accounts of the British Museum, the number of visitors, and the progress made in arranging and adding to the collections for the year ended March 31 last, has been issued. Sir E. Maunde Thompson, director, is quoted in the London *Times*. "It is a matter for regret that a further decline in the number of visits to the Museum has to be recorded for the year 1906. The total number was 691,950, a falling off of nearly 122,000 from the number in 1905. Nor has the decline been confined to week-day visits, as it was in the previous year. The 57,738 visits on Sundays were less by 4,269 than those in 1905. We must go back to the year 1900, with its 689,249 visits, before finding a total to compare with that of the year 1906. At the same time, it is an indication of a steady growth of intelligent interest in the collections that, while the numbers of visits decrease, the sale of guide-books generally tends to increase. The number of visits of students to the reading-room has also been reduced by 2,000, the total for the year being 212,997, as against 214,940 in 1905. The daily average was 702. The average number of persons in the room, counted at the later hours of the afternoon, were: 4 p.m., 349; 5 p.m., 256; 6 p.m., 172; 6:30 p.m., 119. The number of visits of students to particular departments in 1906 was 55,513, as against 57,557 in 1905. The number of visits to the newspaper-room decreased by 2,000; while, as regards other fluctuations, there were 1,200 fewer visits in the sculpure galleries, but 800 more in the department of manuscripts and nearly 1,100 more in the department of British and medieval antiquities."

Sir E. Ray Lankester, the director of the Natural History Museum, says in his report that the total number of visits recorded as having been made to the museum by the public during the year 1906 was 472,557, compared with 566,313 in 1905. This number included 61,151 visitors on Sunday afternoons, as against 70,084 in the previous year. The average daily attendance for all open days was 1,301.8; for week-days only, 1,322.8; and for Sunday afternoons, 1,176. He records presents to the number of 2,057, compared with 2,092 in 1905, the principal donors being the Government of India (collections of Tibetan insects), the Duke of Bedford (zoological specimens from Japan and Korea), Mr. C. D. Rudd (specimens in continuation of his systematic survey of South African fauna), and Mr. W. E. Balston (natural history specimens from Western Australia).

SCIENTIFIC NOTES AND NEWS

Dr. E. Ray Lankester will retire from the directorship of the Natural History Museum, London, in October. It is understood that the inadequate pension originally proposed by the trustees has been about doubled. The trustees have decided not to appoint a new director, though it is possible that this plan may be changed.

Lord Kelvin will open the new science buildings of Queen's College, Belfast, on September 20.

Professor J. P. Iddings, of the University of Chicago, Dr. John M. Clarke, director of the Science Division of the New York Education Department, and Professor R. S. Tarr, of Cornell University, will represent the American Association for the Advancement of Science at the celebration of the centenary of the Geological Society of London to be held this month.

Among the honorary degrees conferred on the occasion of the celebration of the three hundredth anniversary of the University of Giessen, was that of doctor of philosophy on Dr. Ernest W. Rutherford, professor of physics at Manchester, and doctor of medicine on Dr. A. A. W. Hubrecht, professor of zoology at Utrecht. Dr. Hubrecht is at present in this country as delegate to the International Zoological Congress.

An honorary doctorate of medicine has been conferred by the medical faculty of Heidelberg on Baron J. v. Uexküll for his researches on the processes of stimulation in nerves and muscles.

The John Scott legacy medal and premium of the Franklin Institute of Philadelphia has been awarded to Professor J. A. Ewing, F.R.S., and Mr. L. H. Walter for their method of detecting electrical oscillations.

Dr. C. de Bruyn, professor of botany and zoology at Ghent, is president of the Flemish Congress of Naturalists, which meets this month at Malines.

President William DeWitt Hyde, of Bowdoin College, will, owing to the state of his health, probably be unable to return to this country to resume his duties during the present year.

News has been received from the expedition under Mr. Vilhjalmur Stefansson, which in the schooner *Dutchess of Bedford* has been exploring north of the Mackenzie River, that all the members of the expedition are safe.

The daily papers state that Professor Carl C. Lorentzen, of New York University, has arrived at Copenhagen with the object of furthering a scheme for an exchange of professors between Danish and American universities similar to that in vogue between Germany and the United States. Count Raben, the foreign minister, expressed sympathy with the idea and said he would present the proposal at the next session of Parliament.

Under the auspices of the New York Academy of Sciences Dr. D. Le Soüef, director of the Zoological Gardens, Melbourne, Australia, gave an illustrated lecture on "The Wild Animal Life of Australia" at the American Museum of Natural History, on Monday evening, September 9.

Professor Gaylord P. Clark, A.M., M.D., dean of the College of Medicine, Syracuse University, died very suddenly at his residence on September 1. He had but recently returned from several months absence in Europe, and was actively organizing the work of his college for the coming opening. His death is a serious loss to the college and to the university, as well as to the community, and will be greatly regretted by a large circle of his collaborators in physiology.

The deaths are also announced of Dr. E. Petersen, docent in chemistry at the University of Copenhagen, at the age of fifty-one years, and of Giuseppe Grattarola, professor of mineralogy in the Institute for Higher Studies at Florence.

The U. S. Civil Service Commission announces an examination on October 23–24, 1907, to fill a vacancy in the position of anatomist (male), at $1,600 per annum, in the Army Medical Museum, office of the Surgeon General, and other similar vacancies as they may occur there.

THE Royal Botanic Society has received a legacy of about $1,000 from the estate of Mr. Edward Baker, of The Cedars, Clapham-common, for thirty-six years a fellow of the society.

DR. A. GRAHAM BELL has erected at his place at Baddeck, N. S., a tower, eighty feet in height, built of the tetrahedral cells which he invented to secure great strength and lightness in the construction of kites. The engineer was Mr. F. W. Baldwin, of Toronto. It is said that the tower weighs less than five tons and will carry a weight of 50,000 pounds.

AN electrical exhibition has been held in Montreal, commencing on September 2, and from September 11 to 13 the Canadian Electrical Association meets in that city.

THE employees of the Pennsylvania Railroad, numbering 198,000, are to be given a course of practical instruction in first aid to the injured. For this purpose a series of lectures will be delivered at various points along the lines under the direction of the company's medical examiner.

Nature states that two sums, each of 250*l.*, have been received by the Institution of Mechanical Engineers from the Metropolitan Water Board and the chairman of the Court of Arbitration (under the Metropolitan Water Act, 1902), which the donors desire to be used for some engineering purpose connected with the institution. The council have invested the amount—500*l.*—in a trustee security, the income from which they have decided, after consultation with Sir Edward Fry, shall be offered biennially for a paper submitted in accordance with prescribed conditions. It has been further decided that the prize shall be known as the "Water Arbitration Prize," and shall be offered for a paper on an engineering subject to be announced by the council one year before the time for sending in the papers. The prize, which will have a value of approximately 30*l.*, will take any form which the council may from time to time decide.

Nature says: As illustrating further the want of sympathy with scientific research shown by the Indian administrative authorities, to which Professor Ronald Ross, F.R.S., directed attention in an exhaustive article contributed to our issue of June 13, an Indian correspondent writes concerning the rules of the India Office regulating the supply of apparatus to government colleges. According to these rules, our correspondent states, any piece of apparatus of European manufacture—costing more than 3*l.* 7*s.*—can only be obtained by requisitioning through the secretary of state. Requisitions are prepared once a year, and, as a rule, eighteen months elapse between writing a demand and the arrival of the apparatus. It is nearly impossible to foresee everything that may be required during the prosecution of a research, and it happens sometimes that a man of science must wait three years for necessary material. The reasonable contention is made that professors in India should be permitted to spend their laboratory funds themselves and to deal with manufacturers direct. It is surely not taking too much for granted to suppose that men in responsible positions, who presumably have been selected for their posts with great care, may be trusted to administer their funds honestly and to the best advantage of the institutions with which they are connected. The system of having to requisition scientific instruments and materials a year or more in advance is not confined to India, and it is both discouraging to scientific work and wasteful in practise.

MR. FRANCIS FREMANTLE, late plague medical officer in the Punjab writes as follows in the London *Times:* "For nine years," says Lord Curzon, "the Government of India has conducted an unrelenting campaign against the plague . . . by every method, in fine, that science or experience could suggest." As one of the officers employed in that campaign I venture to say that "science" will repudiate the statement. We know the difficulties were immense and that the Indian government did all that occurred to them to do. But, like all governments, they failed to realize that the scientific method of preventing disease is founded on exact knowledge, obtainable only by research. No one knew how plague was

spread. Did they from the first set apart a representative body of experts to give up their whole time to the investigation of this sole problem? The answer is No. It is only now that this has been done, on far too limited a scale, that, as shown me by Captain Lisbon, I.M.S., in 1904, the rat-flea is being proved to play a chief part in spreading the disease. If this is corroborated by further research, a fresh campaign may be devised with considerable hope of success. The moral for all departments of government is the constant cry of "science"—more research.

We learn from *The British Medical Journal* that the eighth session of the Australasian Medical Congress will be held in Melbourne from October 19 to October 24, 1908. The president is Professor H. B. Allen, M.D.; the treasurer, Mr. G. A. Syme, M.B., F.R.C.S., and the general secretary, Dr. H. C. Maudsley, F.R.C.P. The vice-presidents include many leading members of the profession in South Australia, New South Wales, Western Australia, Tasmania, and New Zealand, and there is a secretary in each of the states of the Australian commonwealth, and in the north and south islands of New Zealand. The council of the University of Melbourne has granted the use of its buildings, and the government of Victoria has undertaken to print the transactions of the congress. Addresses will be given at the plenary sessions of the congress by the presidents of the Sections of Medicine (Dr. G. E. Rennie, of Sydney), Surgery (Dr. B. Poulton, of Adelaide), Pathology and Bacteriology (Dr. F. Tidswell, of Sydney) and Public Health (Dr. J. C. Mason, of Wellington, New Zealand). Special meetings will be devoted to the discussion of (*a*) the relations of the medical profession to hospitals, and (*b*) syphilis. There will be eleven sections, the total being completed by the sections of obstetrics and gynecology; anatomy and physiology, with experimental pharmacology; diseases of the eye, ear and throat; neurology and psychiatry; diseases of children; naval and military medicine and surgery; diseases of the skin, radiotherapy and radiography.

UNIVERSITY AND EDUCATIONAL NEWS

A further £2,000 has been given by Sir Donald Currie towards the equipment fund of Queen's College, Belfast, bringing up his contributions to the sum of £22,000.

Lord Selborne laid the foundation stone of Transvaal University College at Johannesburg on August 29.

Foreign journals state that the Governor General of Algeria has brought a proposal for the founding of an Algerian university before the financial delegates, who have adopted it. It will be remembered the late M. Moissan and Professor Bouchard, having inspected the secondary schools in Algiers, reported favorably on the founding of a university. They proposed the establishment of an institute of natural science, experimental botany, zoology and hygiene, and pointed out the political and social effects of the foundation of a university which would form a powerful link between the various races which form the population of Algeria.

The barns of the new agricultural college at St. Anne de Bellevue, near Montreal, were struck by lightning on September 5 and destroyed. The loss is said to be $50,000.

In the medical school of the University of Colorado, Dr. Edward F. Deane has been appointed professor of anatomy; Dr. John Andrew, Jr., demonstrator in anatomy, and Dr. Ross C. Whitman, professor of pathology.

At the University of Chicago, Reuben M. Strong has been appointed instructor in zoology; Victor E. Shelford, associate in zoology, and Frank H. Pike, associate in physiology.

Arthur L. Tatum, of the Ohio State University, has been appointed instructor in chemistry in the University of Colorado.

Harry J. Kesner, B.A., B.S. (Colorado), has been appointed instructor in bridge engineering at the University of Minnesota.

Reginald E. Hore, A.B. (Toronto, '05), formerly demonstrator of mineralogy and petrography in the University of Toronto and member of the staff of the Bureau of Mines of Ontario, has been appointed instructor in petrography in the University of Michigan.